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(54) **Curtain coating device**

(57) The invention relates to a curtain coating device for fiber machines, in particular for paper and board machines comprising a nozzle beam (10) with a nozzle lip (12) with an edge strip (11) for feeding the coating color curtain and edge guides (20) located along each edge of the nozzle lip (12) to control the width of the coating color curtain, which edge guide (20) comprises an upper end, a lower end, flow surfaces (22) extending in substantially vertical direction parallel and next to each other , a lubrication feed (24), additional lubrication feeds (26) and a suction opening (27). The flow surfaces (22) are inclined towards each other and form a flow guide recess (25) extending in vertical direction for an curtain edge guidance such that the form of the flow surfaces (22) with the flow guide recess (25) is concave and that in the flow guide recess (25) is located a protrusion (21) extending in the direction of the flow guide recess.

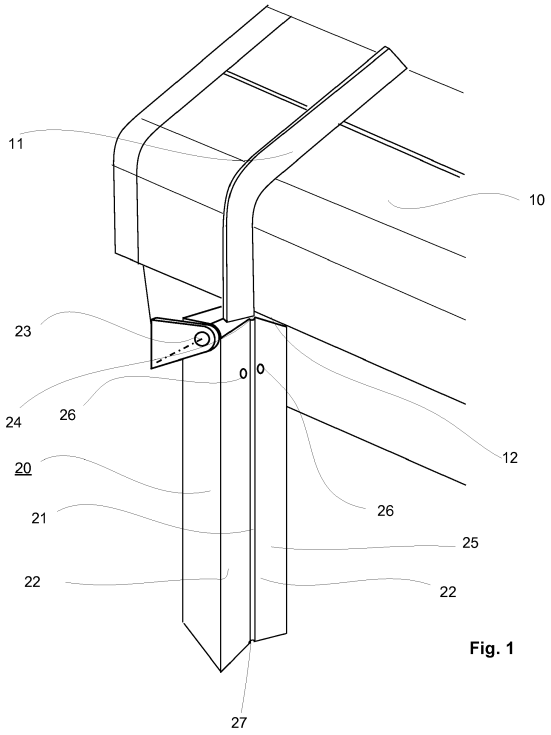

Fig. 1

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Description

[0001] The invention relates to a curtain coating device for fiber machines, in particular for paper and board machines. More especially the invention relates to a curtain coating device in accordance with features of the preamble part of claim 1.

[0002] Coated fiber web grades and coating are becoming more and more popular and thus the coating process and equipment have increasing demands imposed thereon. In coating, especially in pigment coating, the surface of a fiber web is formed with a layer of coating color (coating agent) at a coating station followed by drying. The process of coating can be divided in supplying the coating color onto the web surface, which is called the application of the coating color, as well as in the adjustment of final amount of coating color. One important recently developed coating technique is curtain coating, which is suitable to coat paper and board. By curtain coating good coverage of coating color on the web surface to be coated is achieved.

[0003] In curtain coating two main types of curtain coating devices are used, namely curtain coating devices with slot-fed and curtain coating devices with slide-fed. In the slide fed curtain coating devices, coating color is fed by means of a nozzle assembly onto an inclined plane and the coating color flows down towards an edge of the plane constituting a nozzle lip and the curtain is formed as the coating color falls off the nozzle lip onto the web. In the slot-fed curtain coating devices coating color is pumped through a distribution chamber into a narrow vertical slot and the curtain is formed at its lip and falls onto the web. Coating can be applied in one or more curtain layers.

[0004] Typically two different methods are used to control width of the curtain. One is to feed the curtain wider than width of the fiber web to be coated and then the width is allowed freely narrow in cross direction of the web as the curtain falls downwards towards the fiber web. This method is called as out-board method. The other, called as in-board method, is to feed the curtain narrower than the width of the fiber web to be coated, and the width is required to maintain uniform as the curtain falls downwards towards the fiber web. The curtain is maintained at required width by means of edge guides which are located along each edge of the feeding slot / the nozzle lip. An edge guide typically comprises a flow surface for guiding the edge of the coating curtain, a lubrication liquid (typically water) supply(s) onto edge guide, a collecting lip and a suction channel for collecting and removing edge area coating color and lubrication liquid. The present invention relates to in-board curtain coating and to the edge guides used to keep the curtain at required width.

[0005] In WO publication 03/049870 is disclosed an edge guide for a curtain coater has at least one contact area of its surface directed towards a coating curtain, which contact area has a multiplicity of grooves and ribs extending along the length of the edge guide.

[0006] In EP patent publication 1817115 is disclosed an edge guide for a curtain coating device having a guide surface with a guide groove, at least one liquid feed and a quietening section.

[0007] In EP patent publication 1900441 is disclosed an edge guide of a curtain coating device, comprising liquid supply means, wherein a member constituting a surface of the edge guide, which faces the coating color layer is a porous material member.

[0008] In US patent publication 7160579 is disclosed an edge guide for a curtain coating device with a groove having incorporated in its surface channels parallel to the direction of the falling curtain and the curtain is stabilized with liquid flow which is supplied to the groove.

[0009] One problem in all known edge guides for curtain coating devices is stability of the curtain on the edge guide, especially when the feed amounts of the coating color are low.

[0010] Another problem is adhering and drying of the coating color onto the edge guide and especially onto the suction channel of the edge guide, which disturbs the coating process.

[0011] Problems at edge areas of the curtain are mainly related to four different factors to which construction of the edge guide effects: firstly coating color thickness on the area between the sliding surface of nozzle beam and edge strip, secondly encounter location of three boundary surfaces where the edge guide is connected to the nozzle beam, thirdly material, form and inclination angle of the edge guide and lubrication / moisturizing liquid fed onto the edge guide and fourthly removal of lubrication / flushing liquid by suction at lower edge of the edge guide. The present invention relates to the latter three of the above mentioned factors.

[0012] In known edge guides for curtain coating devices the encounter location of three boundary surfaces where the edge guide is connected to the nozzle beam is problematic, since this encounter location of three boundary surfaces causes disturbances to the flow of the curtain and differences in surface energy of the surfaces cause problems. The three surfaces include nozzle beam (the lip of the nozzle), edge guide and edge strip.

[0013] An object of the invention is to create a curtain coating device in which the disadvantages of the prior art, especially relating to edge guides, are eliminated or at least minimized.

[0014] A further object of the invention is to solve the problems relating to the stability of the curtain on the edge guide.

[0015] A further object of the invention is to solve the problem relating to adhering of the drying coating color onto the flow surface and the suction channel of the edge guide.

[0016] In order to achieve the above objects and those that will come apparent later the curtain coating device according to the invention is characterized by the features of the characterizing part of claim 1. Advantageous embodiments and features are defined in dependent

claims.

[0017] According to the invention the curtain coating device for fiber machines, in particular for paper and board machines comprises a nozzle beam with a nozzle lip with an edge strip for feeding the coating color curtain and edge guides located along each edge of the nozzle lip to control the width of the coating color curtain, which edge guide comprises an upper end, a lower end, flow surfaces extending in substantially vertical direction parallel and next to each other , a lubrication feed, additional lubrication feeds and a suction opening, which flow surfaces are inclined towards each other and form a flow guide recess extending in vertical direction for an curtain edge guidance such that the form of the flow surfaces with the flow guide recess is concave and that in the flow guide recess is located a protrusion extending in the direction of the flow guide recess.

[0018] According to an advantageous feature the upper end of the edge guide is at a small distance from the nozzle lip of the nozzle beam. The small distance decreases the number of encounter location from three boundary surfaces to two. It also helps to make the edge guides to be inclined. If needed, also a width control of the application area on cd-direction is easier to make, like in the FI patent application 20075893. The upper end of the edge guide can also be touching the nozzle lip.

[0019] According to an advantageous feature the lubrication liquid feed is located at the boundary of the edge strip and the upper end of the edge guide between the edge strip and the flow surfaces of the edge guide. Some lubrication feeds can be located also on the edge strip area at the nozzle beam.

[0020] According to an advantageous feature at a distance from the upper end of the edge guide downstream is located at least one additional lubrication feed on one side of the protrusion.

[0021] According to an advantageous feature at a distance from the upper end of the edge guide downstream are located the additional lubrication feeds on both sides of the protrusion.

[0022] According to an advantageous feature the upper end of the edge guide the edge guide is inclinable in respect to vertical direction by means for adjusting the inclination angle of the edge guide. According to an advantageous feature the inclination angle of the edge guide is adjustable. According to an advantageous feature inclination angle of the edge guide is adjustable during coating.

[0023] According to an advantageous feature the protrusion has arched form.

[0024] According to an advantageous feature the suction opening of the edge guide is located at lowermost point of the lower part of the edge guide. Some moisturizing feeds can also be located on the suction area to help the suction channel to be kept as open.

[0025] According to an advantageous feature the edge strip of the nozzle beam is extended over the nozzle lip of the nozzle beam and the edge strip is joined to the edge guide smoothly by a curved form directly or slightly apart.

[0026] According to an advantageous feature the means for adjusting the inclination angle of the edge guide, there is a hinge located in the upper end of the edge guide and the center point of the radius of the curved form in the upper part of the edge guide is substantially on the center line of the hinge. The curved form of the upper part of the edge guide helps to maintain the geometry between the edge guide and edge strip essentially same when changing the inclination, thus maintaining the flow conditions as required without disturbances.

[0027] According to an advantageous feature the edge guide is inclined from the vertical direction about 1 ° to 3 °. Further according to an advantageous feature the edge guide has means for adjusting the inclination angle even during coating.

[0028] According to an advantageous feature the suction opening is one suction hole, which has a circular cross section.

[0029] According to an advantageous feature the flow surfaces are inclined towards the flow guide recess and the inclination angle of each flow surface is advantageously at least 0,5 ° and more advantageously 2 - 5 °.

[0030] According to an advantageous aspect of the invention the upper end of the edge guide is at a small distance from the nozzle lip of the nozzle beam. By this the problematic encounter location of three boundary surfaces is removed. According to an advantageous feature the edge strip of the sliding plane on the level of the nozzle beam is extended over the nozzle lip of the nozzle beam, whereby the coating color flows over the edge strip without disturbances. According to an advantageous feature the edge strip is connected to the edge guide smoothly such that to the connecting surface area lubrication liquid is fed from inside the surface. By this a very advantageous construction is achieved as the coating color flow surface continues on a lubricated surface without discontinuity. The lubrication liquid fills any flatness defects on the surface and improves the ratios of surface energy and surface tension between the coating color and its flow surface.

[0031] According to an advantageous aspect of the invention the additional lubrication liquid is fed at an advantageous location in respect of the flow of the curtain and thus according to an advantageous feature of the invention additional lubrication liquid is fed at a distance downstream of the curtain on one or on each side of the curtain in thickness direction of the curtain. During the flow downstream the curtain recovers the required amount of lubrication liquid and the rest of the lubrication liquid keeps the flow surface clean. By this is ensured that adequate amount of lubrication liquid is fed and thus the lubrication remains good all the way down of the edge guide.

[0032] According to an advantageous aspect the flow surfaces of the edge guide are inclined towards each other and form the flow guide recess with the protrusion

in the center, i.e. where the flow surfaces join in vertical direction. The flow surfaces are thus inclined towards the protrusion and form the concave recess with the protrusion, which prevents the spreading of the lubrication liquid to surrounding areas. It is know that the curtain seeks support from boundary surfaces, which are close to each other, which might cause the concave surface to be unfavorable but according to an advantageous feature of the invention this is solved by a protrusion located at the bottom of the concave surface, where by the curtain follows this protrusion.

[0033] According to an advantageous aspect of the invention the suction opening for the lubrication liquid removal is located at the curtain edge area at the lowermost part of the edge guide, advantageously at the lowermost point of the edge guide. According to an advantageous feature the suction opening is one suction hole, which has circular cross section, at the bottom corner of the edge guide. Circular opening is advantageous is respect of cleaning and the location at the bottom corner of the edge guide makes it possible to have the suction opening at the lowest point of the structure. By these the edge guide can be positioned even at contact with the fiber web and at least very near to the fiber web. By the magnitude of the suction necking and separation of the coating color curtain can be controlled. By the circular suction opening is also achieved that the necking of the curtain occurs at the opening and thus the suction opening maintains clean. The diameter of circular opening is at least the width of the protrusion, at least 2 mm and advantageously 3-6 mm, to ensure a trouble-free suction without plugging the opening.

[0034] In this description and claims by terms upper, lower, uppermost and lowermost are meant parts in respect of the position of the edge guide in view of the fiber web to be coated such that upper is further from the fiber web and lower is closer in view of the fiber web. The vertical direction is to be considered to be the perpendicular direction in view of the main plane direction of the fiber web.

[0035] In the following the invention will be explained more closely by reference to the accompanying drawing in which

In figure 1 is schematically presented one advantageous example of an edge guide of a curtain coating device in accordance with the invention,

in figure 2 is schematically presented the upper part of the edge guide of the example of figure 1,

in figure 3 is schematically presented the lower part of the edge guide of the example of figures 1 and 2,

in figure 4 is schematically presented the flow surfaces of the edge guide of the example of figures 1 - 3 and

in figures 5A - 5C is schematically presented examples of flow guide recess of the edge guide of a curtain coating device in accordance with the invention.

[0036] During the course of the following description of figures 1 - 5C like numbers and signs will be used to identify like elements, parts and part components unless otherwise mentioned. In the figures some references sign have not been repeated for clarity reasons. In the following the examples are described mainly by reference to an edge guide of a curtain coating device of a fiber web in view of simplifying the disclosure but it should be noted that instead of this example any type of an edge guide of curtain coating device can have similar features and properties in accordance with the invention.

[0037] In the example of figure 1 the edge guide 20 of a curtain coating device is attached to the nozzle beam 10 of the curtain coating device. The coating color curtain is formed by nozzles of the nozzle beam 10 and guided via the nozzle lip 12 towards the fiber web. The width of the coating color curtain is controlled by edge guides 20, of which one is shown in figure 1. The edge guide 20 is located below the edge strip 11 of the nozzle beam 10. The edge strip 11 guides the curtain to the edge guide 20. The edge guide 20 is connected to the nozzle beam 10 by a hinge 23, by which the inclination of the edge guide 20 in respect of vertical direction is controllable even during coating. The inclination is advantageously 1 - 3 °. Between the edge strip 11 and the upper end of the edge guide 20 is located a lubrication liquid feed 24, which feeds lubrication liquid between the edge guide 20 and the edge strip 11. The curtain edge is guided downwards by the flow surfaces 22 of the edge guide 20. The flow surfaces 22 form a flow guide recess 25 in the middle and the flow surfaces 22 with the flow guide recess 25 are in concave form. In the flow guide recess 25 is located a protrusion 21 extending in the direction of the flow guide recess 25, which protrusion 21 guides the edge of the coating color curtain in the flow guide recess 25. The protrusion is advantageously shaped so that its form fits inside a half-circle, which has maximum radius 7,5 mm. Additional lubrication feeds 26 are located at a distance from the upper end of the edge guide providing lubrication liquid to both sides of the curtain edge in thickness direction of the curtain. At the lower end of the edge guide in the bottom corner is located suction opening 27 for removing excess lubrication liquid and for necking the curtain to the fiber web.

[0038] In figure 2 is presented the upper part of the edge guide 20 of the example of figure 1. As indicated by arrow R the uppermost part of the edge guide 20 at the upper end of the edge guide has curved form with a radius R that corresponds to the center line of the hinge 23. The edge strip 11 connects to the upper end of the edge guide 20 smoothly. The lubrication liquid is fed by lubrication feed 24 from between the edge strip 11 and the upper end of the edge guide 20. The upper end of the edge guide 20 is either touching or located at a small

distance, for example 0,5 - 2 mm, from the edge strip 11. At a distance D, for example 5 - 50 mm from the upper end of the edge guide 20 the additional lubrication feeds 26 are located.

[0039] In figure 3 is presented the lower part of the edge guide 20 of the example of figures 1 and 2. The curtain edge is guided downwards by the flow surfaces 22 of the edge guide 20. The flow surfaces 22 form a flow guide recess 25 in the middle and the flow surfaces 22 with the flow guide recess 25 are in concave form. At the lower end of the edge guide 20 in the bottom corner is located suction opening 27 for removing excess lubrication liquid.

[0040] In figure 4 is presented the flow surfaces 22 of the edge guide 20 of the example of figures 1 - 3. The flow surfaces 22 form a flow guide recess 25 in the middle and the flow surfaces 22 with the flow guide recess 25 are in concave form. The flow surfaces 22 are inclined towards the middle and towards the flow guide recess 25 and the inclination angle A is advantageously 2 - 5 °. In the middle of the flow surfaces 22 is formed the flow guide recess 25 with a protrusion 21.

[0041] In figures 5A - 5C is presented some examples of flow guide recess 25 with the protrusion 21 of the edge guide 20. In figure 5A the form of the protrusion 21 is outwards arched and in figures 5B and 5C angular. In the example of figure 5B the protrusion 21 has an additional inwards arched groove 28. In figure 5B the cross section is shown at the location of the additional lubrication feeds 26, which are located on each side of the protrusion thus lubricating the curtain from each side in thickness direction. The flow surfaces 22 are inclined towards the middle and towards the flow guide recess 25 and the inclination angle A if each flow surface 22 is advantageously 2 - 5 °.

[0042] In the following some main points of the example of the figures 1 -4 is further explained. The curtain coating device comprises a nozzle beam 10 with a nozzle lip 12 with an edge strip 11 for feeding the coating color curtain and edge guides 20, which are located along each edge of the feeding slot / the nozzle lip 12 to control the width of the curtain. The upper end of the edge guide 20 is at a small distance from the nozzle lip 12 of the nozzle beam 10. The edge strip 11 of the nozzle beam 10 is extended over the nozzle lip 12 of the nozzle beam 10, whereby the coating color flows over the edge strip 11 without disturbances. The edge strip 11 is connected to the edge guide 20 smoothly by a curved form. Lubrication liquid is fed to the connecting surface area by lubrication feed 24 from inside onto the surfaces 22. Additional lubrication liquid is fed from additional lubrication feeds 26 at a distance D from the upper end of the edge guide 20 downstream of the curtain on each side of the curtain in thickness direction of the curtain. The flow surfaces 22 with the flow guide recess 25 of the edge guide 20 are in its form concave towards the curtain. Advantageously the edge guide 20 inclined from the vertical direction about 1 ° to 3 ° and the edge guide 20 has means for adjusting the inclination angle even during coating. The means for adjusting the inclination angle are advantageously the hinge 23 located near the upper end of the edge guide 20 and the center point of the radius R is on the center line of the hinge 23. The suction opening 27 for the lubrication liquid removal is located at the bottom corned of the edge guide at the curtain edge area. Advantageously the suction opening 27 is one suction hole, which has circular cross section.

[0043] In the previous only one advantageous example of the invention is described. Many modifications and alterations are possible in view of the invention.

Reference signs used in the drawing:

[0044]

10	nozzle beam
11	edge strip
12	nozzle lip
20	edge guide
21	protrusion
22	flow surface
23	hinge
24	lubrication feed
25	flow guide recess
26	additional lubrication feed
27	suction opening
28	groove of the protrusion
R	radius of uppermost part of the edge guide
D	distance of additional lubrication feeds from the upper end of the edge guide
A	inclination angle of flow surfaces towards middle

Claims

1. Curtain coating device for fiber machines, in particular for paper and board machines comprising a nozzle beam (10) with a nozzle lip (12) with an edge strip (11) for feeding the coating color curtain and edge guides (20) located along each edge of the nozzle lip (12) to control the width of the coating color curtain, which edge guide (20) comprises an upper end,

a lower end, flow surfaces (22) extending in substantially vertical direction parallel and next to each other , a lubrication feed (24), additional lubrication feeds (26) and a suction opening (27), **characterized in, that** the flow surfaces (22) are inclined towards each other and form a flow guide recess (25) extending in vertical direction for an curtain edge guidance such that the form of the flow surfaces (22) with the flow guide recess (25) is concave and that in the flow guide recess (25) is located a protrusion (21) extending in the direction of the flow guide recess.

2. Curtain coating device according to claim 1, **characterized in, that** the upper end of the edge guide (20) is touching the nozzle lip (12) of the nozzle beam (11).

3. Curtain coating device according to claim 1, **characterized in, that** the upper end of the edge guide (20) is located at a small distance, for example 0,5 - 2 mm, from the nozzle lip (12) of the nozzle beam (11).

4. Curtain coating device according to any of claims 1 - 3, **characterized in, that** the lubrication liquid feed (24) is located at the boundary of the edge strip (11) and the upper end of the edge guide (20) between the edge strip (11) and the flow surfaces (22) of the edge guide (20).

5. Curtain coating device according to any of claims 1 - 4, **characterized in, that** at a distance (D) from the upper end of the edge guide (20) downstream is located at least one additional lubrication feed (26) on one side of the protrusion (21).

6. Curtain coating device according to any of claims 1 - 5, **characterized in, that** at a distance (D) from the upper end of the edge guide (20) downstream are located additional lubrication feeds (26) on both sides of the protrusion (21).

7. Curtain coating device according to any of claims 1 - 6, **characterized in, that** the edge guide (20) is inclinable in respect to vertical direction by means (23) for adjusting the inclination angle of the edge guide (20).

8. Curtain coating device according to any of claims 7, **characterized in, that** the inclination angle of the edge guide (20) is adjustable during coating.

9. Curtain coating device according to any of claims 1 - 8, **characterized in, that** the protrusion (21) has arched form.

10. Curtain coating device according to any of claims 1 - 9, **characterized in, that** the suction opening (27) of the edge guide (20) is located at lowermost point of the lower part of the edge guide (20).

11. Curtain coating device according to any of claims 1 - 10, **characterized in, that** the edge strip (11) of the nozzle beam (10) is extended over the nozzle lip (12) of the nozzle beam (10) and that the edge strip (11) is connected to the edge guide (20) smoothly by a curved form.

12. Curtain coating device according to any of claims 6 - 8 or 11, **characterized in, that** the means for adjusting the inclination angle is a hinge (23) located in the upper end of the edge guide (20) and the center point of the radius (R) of the curved form in the upper part of the edge guide (20) is on the center line of the hinge (23).

13. Curtain coating device according to claim 10, **characterized in, that** the suction opening (27) is one suction hole, which has a circular cross section.

14. Curtain coating device according to any of claims 1 - 13, **characterized in, that** the flow surfaces (22) are inclined towards the flow guide recess (25) and the inclination angle (A) of each flow surface (22) is advantageously 2 - 5 °.

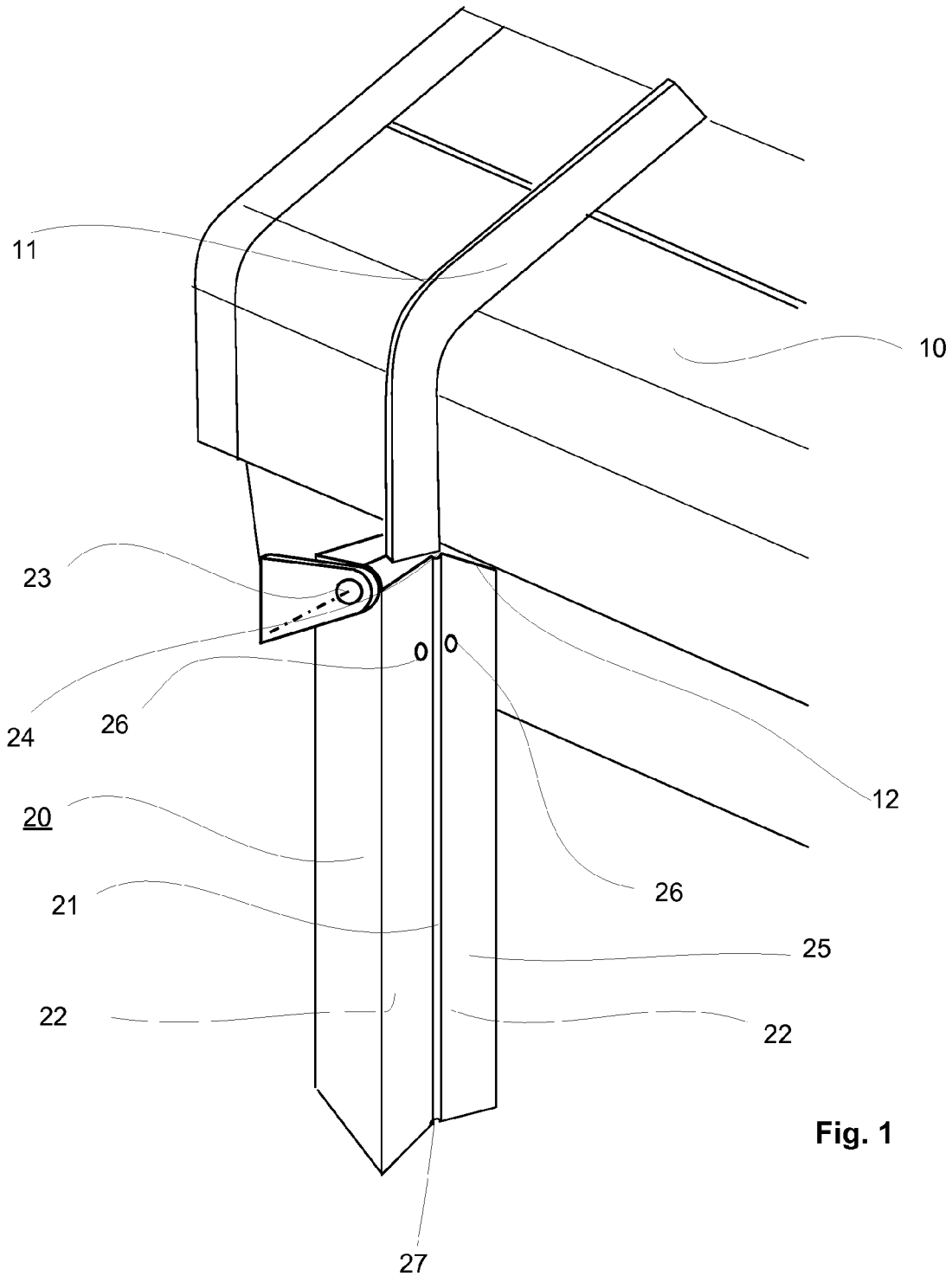

Fig. 1

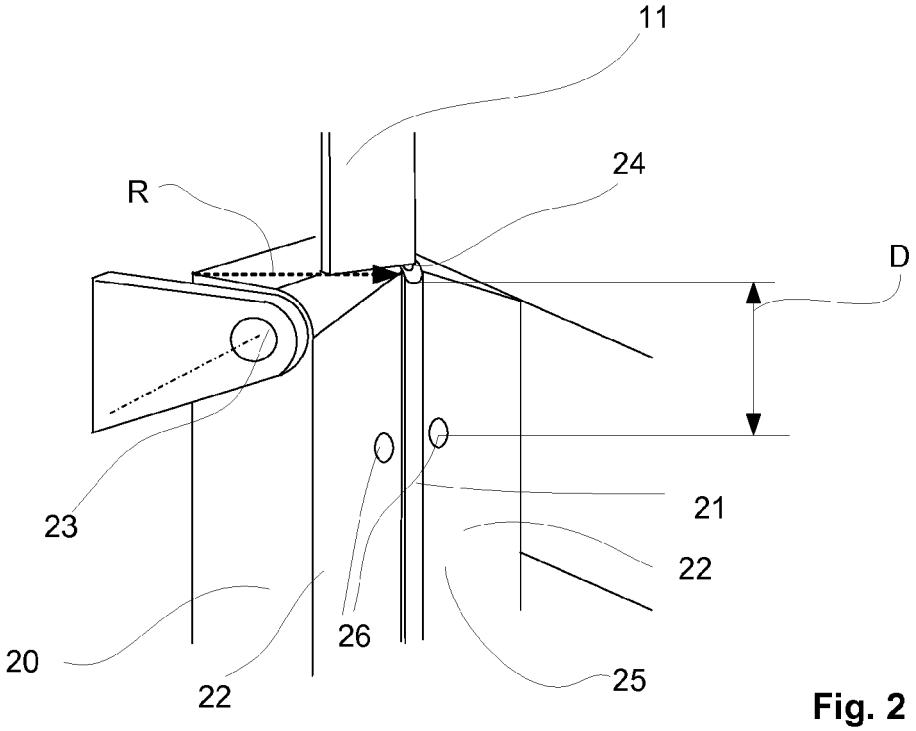

Fig. 2

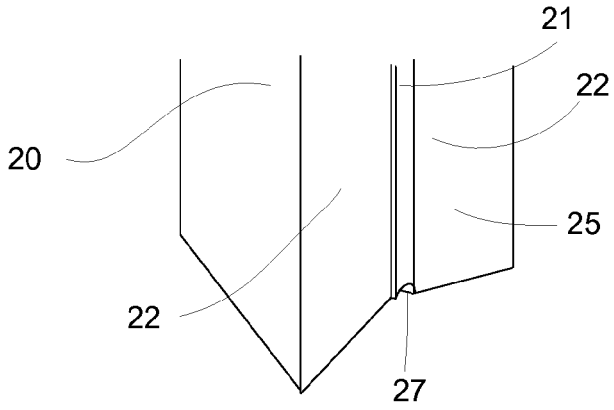

Fig. 3

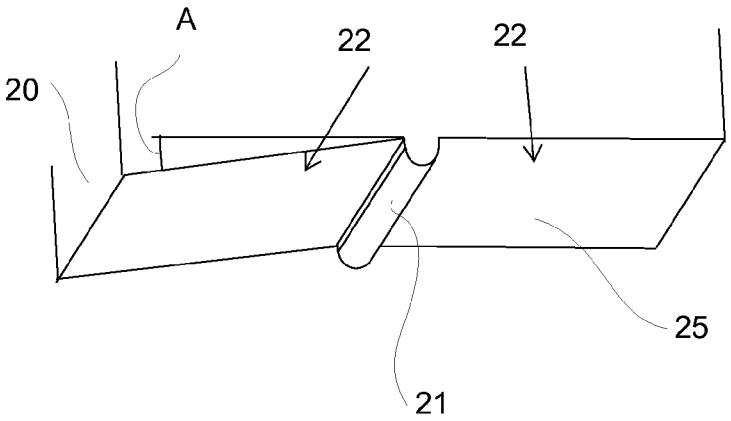

Fig. 4

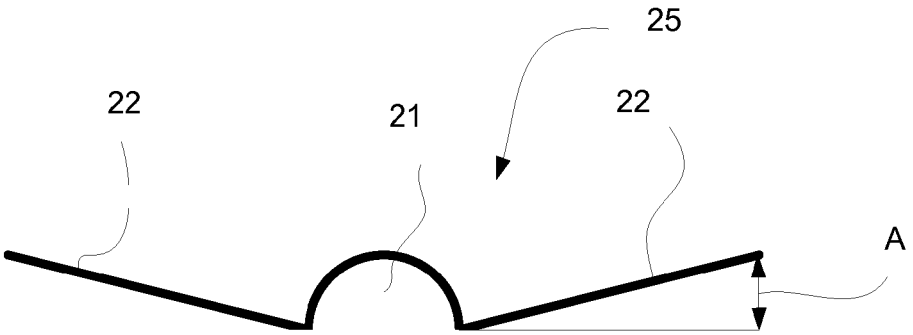

Fig. 5A

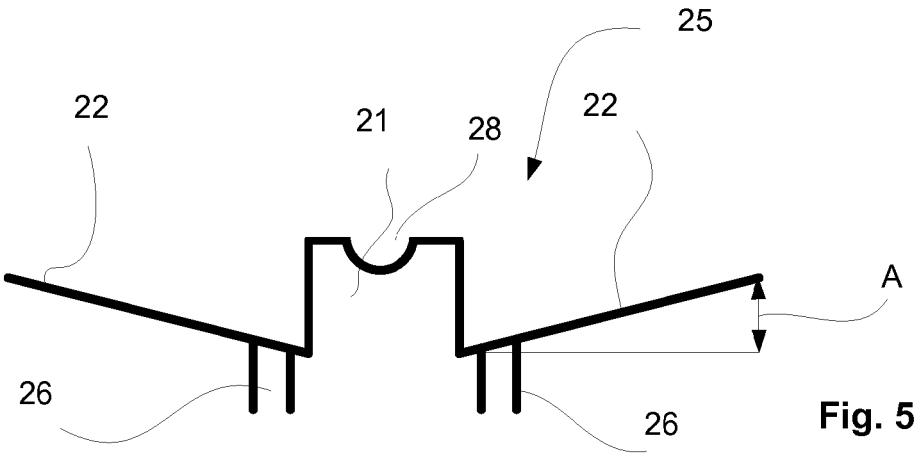

Fig. 5B

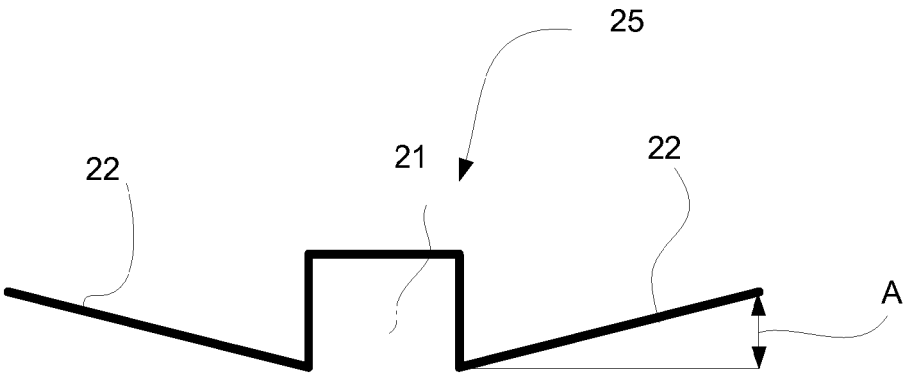

Fig. 5C

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EUROPEAN SEARCH REPORT

Application Number
EP 14 17 1250

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	EP 2 474 368 A1 (VOITH PATENT GMBH [DE]) 11 July 2012 (2012-07-11) * abstract; figures 1-12 * * page 3, paragraph 3 - page 4, paragraph 13 * * page 8, paragraph 32 - page 8, paragraph 37 *	1,4, 6-11,13, 14	INV. B05C5/00 D21H23/56 G03C1/00 D21H23/48
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Y	EP 2 292 336 A1 (RICOH CO LTD [JP]) 9 March 2011 (2011-03-09) * abstract; figures 1-7 *	1-5,12, 13	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 November 2014	Frego, Maria Chiara

CATEGORY OF CITED DOCUMENTS

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